Assessing the Social and Academic Supports in a STEM Living Learning Community

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Abstract

This study focuses on a living learning community called the Chancellor's Science Scholars (CSS) Program. The program is committed to bringing in underrepresented students into the science, technology, engineering, and mathematics (STEM) field. Scholars are offered academic supports as well as social supports. Students provide assessments of their experiences at the end of each year in the program. This study examines how community, science identity, and science self-efficacy relate to students' perceived benefit of and satisfaction in the program. Results show that scholars' science-self efficacy did not improve over time and that scholars' sense of community decreased over time. Sense of community and science identity are significant predictors of community involvement. Excerpts from student end-of-year interviews are included in discussions for future research. These findings may serve to improve the CSS program, as well as STEM learning communities in development.

Assessing the Social and Academic Supports in a STEM Living Learning Community

Science, technology, engineering, and mathematics (STEM) occupations account for six percent of the total American workforce. These occupations lead to innovation and scientific discovery that may improve American citizens' standard of living as well as the economy as a whole. STEM occupations are competitive, require a college education, but offer high salaries and other benefits. Historically, women and racial minorities have been underrepresented in STEM occupations. Men are employed at twice the rate of women in STEM professions. The rate of employment for women increased rapidly from 1970 to 1990, but has declined below the level of men steadily since the 1990's. Recent decades show even less growth in STEM employment for younger women. Women comprise half of the college-educated workforce, but account for only 29% of the STEM workforce. Historically, Black and Hispanic people have been significantly underrepresented in STEM occupations, and these rates have not improved over time (Landivar, 2013).

One explanation for the lack of improvement includes stereotype threat. Typically observed from standardized testing, stereotype threat may also provide negative reinforcement for STEM under-representation in minority students. In this study, stereotype threat can be defined as an added pressure that poor performance or failure in the STEM courses may be judged as a negative stereotype for someone of that group. In theory, students who feel added pressure and negatively stereotyped by their identity in a given field, remove themselves from that field to alleviate the added stress their pursuit of a STEM career brings. Although the threat is driven by a group-based way of thinking, interventions at the individual level have proven successful. One study implemented an individual based intervention of having women read an article that highlighted the growth of women STEM and found that the intervention significantly improved their performance on a standardized math exam compared to women in the control, exposed to stereotype threat (Shaffer, 2013).

Racial minorities are also significantly affected by stereotype threat in the STEM field as well as academia at large. Another study found that chronic stereotype threat has long term consequences, including de-identification from social domains. When students de-identify with a given major or course of study, they lose motivation to continue pursuing that field. That is why it is essential to combat these stereotypes and provide special supports for minority students pursuing STEM education (Woodcock, 2012). Creating an environment where underrepresented students are represented by successful scientists who share their identity can foster a community where students' commitment to their goals are stronger than their fear of failure. This phenomenon is the inspiration for learning communities such as the Meyerhoff Scholars and the Chancellor's Science Scholars Program.

The Chancellor's Science Scholars Program Components and Supports

The Chancellor's Science Scholars began at the University of North Carolina at Chapel Hill in 2013. The program is a partnership with the Meyerhoff Scholars Program and the Howard Hughes Medical Institute. The purpose of both the Meyerhoff and Chancellor's Science Scholars program is to bring underrepresented students into the STEM workforce. These under-represented students face unique barriers to succeeding in theses fields. Recognizing this, program coordinators developed the Chancellor's Science Scholars program to help students become contributing scientists and scholars in the STEM field. Underrepresented students selected for the program include, but are not limited to, first generation college students, students from low socio-economic backgrounds, women, and students from underrepresented racial groups in particular STEM fields.

Students apply to the program when applying to the University of North Carolina at Chapel Hill. The applicants are then invited to the University for a selected students weekend to learn more about the program and participate in interviews with STEM faculty and University staff. Students that are accepted into the program receive a $10,000 merit scholarship per academic year. To receive continued financial assistance students must be enrolled full-time, maintain a GPA above 3.0 and have one major in a field of STEM. Students must also intend to pursue a doctorate or combined MD/PhD in a STEM related field and be committed to promoting diversity in the field of STEM.

Accepted students in the Chancellor Science Scholar's (CSS) program are required to complete a summer bridge program. As the name suggests, summer bridge programs function to support students academically and socially as they bridge the gap between high school and college. The Summer Bridge Program aims to help transition students from their high school learning environment to the more rigorous academic standard of their University. Chancellor Science Scholars are enrolled in a science-specific summer bridge program called Summer EXCELerator. Students receive accelerated entry to UNC and before the fall semester starts, take up to two introductory courses in the sciences with focused one-on one attention from professors. The program also includes seminars, group studies, trainings, and social and cultural events that allow members of the program to interact and engage in problem-based learning activities. The students are also given opportunities to network with UNC faculty and learn about prospective majors, professional schools, and student organizations.

While the program functions to serve students academically, the program offers many social opportunities. During the Summer EXCELerator, students live on campus and are connected with other incoming first-year students in the Chancellor's Science Program before the start of classes in the fall. This ability to live on campus in dormitories gives students the opportunity to interact socially with other students in their cohort and and become more comfortable with the university setting before the fall semester begins. At a large, public university such as UNC, the ability to start in a small, centered community is a unique opportunity. Similarly, the academic attention students in the Summer Bridge Program receive is more focused and individualized than academic support received during a student's first year. Class sizes for introductory science courses CSS scholars take can be as large as 400 students. Finding individual help in these courses can be challenging, especially if students have scheduling conflicts during a professor's office hours. CSS connects scholars with faculty in their courses and organizes private tutoring and academic coaching for these students. Scholars also have priority registration to ensure they get into the classes that are needed for their STEM majors after their first year of involvement the program.

Summer Bridge Programs such as CSS' Summer EXCELerator can provide enriching opportunities for all students but research has shown that the program has the greatest benefits for under-represented students such as racial minorities, students from a low socio-economic-status, and first generation college students. These underrepresented students are represented in all cohorts of the Chancellor's Science Scholars. There has been a rise in college enrollment for under-represented populations of students, but these students are still more likely to lack the basic skills necessary for success in college and require additional coursework (Strayhortn, 2011). Many institutions nationally are funded to provide Summer Bridge Programs and other pipeline programs to promote college readiness and success. There is limited research on what about these programs impacts underrepresented students. One study conducted on students from underrepresented racial groups participating in a summer bridge program found that participation in the program not only significantly increased students' academic skills, but also their academic self-efficacy. Furthermore, when controlling for confounding variables, this measure of self-efficacy was found to be a significant predictor of the summer bridge students' first semester GPA in college (Strayhorn, 2011).

After completing the summer bridge program, students continue to engage in the Chancellor Science Scholars learning community. For students' first year in the program, they are required to live with a roommate who is also a CSS scholar, and all first-year scholars are housed in the same dorm. This first year living requirement of the program helps ensure that students find social supports and are encouraged to engage in the community with other scholars. Students additionally are required to live on campus until junior year. After junior year, students may have the opportunity to live off campus.

For their four years, scholars are given program specific academic advising and counselling. Program counselors assist students with professional development, applying for internships, getting involved in research, and networking in and outside of the University setting. Academic advisors meet with students to discuss their goals and help plan what courses and opportunities are available within the University to help them meet their academic and career goals. The Chancellor's Science Scholars program is committed to academic excellence as well as efficacy. Both the Meyerhoff Scholars and Chancellor Science Scholars program place great emphasis on students becoming a part of the scientific community and enhancing their STEM efficacy through academic and social support. Both the quality of students' educational experiences and his or her belief in being able to achieve in STEM were found to be two significant predictors of whether a student chose to pursue a STEM focused major (Heilbronner, 2011).

Guiding Theory

When exploring the construct of science self-efficacy, Bandura's (1977) theory of self-efficacy as behavioral change will serve as a frame for the study. Self efficacy is defined by Bandura as the following: "People's beliefs about their capabilities to produce a designated level of performance that exercise influence over events that affect their lives" (Bandura, 1994). In the present study, the definition of science self efficacy can be applied to Bandura's definition as students' beliefs about their ability to achieve academic success in a field of science and achieve mastery to contribute a given STEM field. The model of self-efficacy explains how these efficacy expectations influence behavior. An efficacy expectation is a belief that one can behave to produce a desired outcome based on his or her confidence in a given ability. Efficacy expectations can be a major factor in how persistent one is toward reaching goals in the face of obstacles. Therefore, those with stronger self-efficacy will be more likely to persist toward a goal and gain resiliency toward adversity and obstacles by having corrective experiences that may instill that sense of efficacy beyond the threat of challenge.

When applied to the Chancellor's Science Scholars model of student intervention, self-efficacy and in particular science self-efficacy must be addressed. As discussed, underrepresented students in the field of STEM face unique challenges and obstacles to persisting in the field. Enhancing students' beliefs in their own ability to contribute to the field of STEM can motivate their behavior to pursue experiences and opportunities within the program that will ready them for higher education and or a career in a STEM field. Self-efficacy also drives outcome expectancy. Outcome expectancy can be defined as one's anticipated outcome of a efficacy motivated behavior. Those with higher efficacy have higher outcome expectancies and thus put more effort into meeting their goals. This theory supports that scholars in the CSS program who have boosts in efficacy will have higher achievement and contribute to the field of STEM.

The finding that self-efficacy drives outcome expectation led to the foundation for Lent and Brown's (1994) Social Cognitive Career Theory. The theory is explained by a similar conceptual understanding of Bandura's (1977) theory of self efficacy with an added step. Social Cognitive Career Theory explains that outcome expectation influences one's motivations and interests and in turn these motivations and interests lead to prospective career choices. The theory takes into consideration how the social expectations and barriers influence one's cognitive appraisal of a profession or career-driven goal. In return, this personal belief drives one's behavior to pursue or avoid a given career path. Thus, enhancing efficacy in a given field would enhance one's desire and interest in persisting in a field to market for a career.

Within Social Cognitive Career Theory, social supports at an individual or group level could affect career trajectory. A sense of belonging in a STEM field reinforces the idea that a student belongs in that field. The feeling of belonging contributes to a greater interest and social engagement which in turn points students in the direction of a STEM-focused career. Students from underrepresented groups may lack this sense of belonging in Predominately White Institutions and are thus more likely to change to a non-STEM major than white students (Strayhorn 2011). These theories provide support for the Chancellor's Science Scholars and Meyerhoff Program's emphasis on community based learning and social support to boost efficacy and achievement for underrepresented STEM majors (Fouad, 2017).

Empirical Support for STEM Focused Living Learning Communities

As noted before the Myerhoff Scholars Program inspired the Chancellor's Science Scholars program at UNC. The program began in the late 1980's. UMBC enrolled its first class in 1989, a cohort of only African American men. As time passed, women and other underrepresented racial and social minorities in STEM were included in the program as well. All students are now welcome to apply, but similar to the Chancellor's Science scholars staff, their admissions council selects students for the program who bring diversity to the field. The Meyerhoff Program similarly aims to bring underrepresented students into STEM fields. The long-term effects of the Chancellor's Science scholars remain unknown, for the first cohort will be graduating with the class of 2017 in May. However, The Meyerhoff Scholars Program has seen long-term effects, keeping track of graduates from the program and measuring their outcomes. To date, Meyerhoff Scholars alumni have earned 231 PhDs and 300 alumni are currently enrolled in graduate and professional degree programs (UMBC, 2016).

The first study conducted with Meyerhoff Scholars focuses on cohorts of exclusively African American students. For this study, Meyerhoff Scholars were compared to other African American students who declined the offer to participate in the program. Survey data revealed that Meyerhoff Scholars (both male and female) were more successful in science, engineering, and mathematics (SEM) majors than compared to equally qualified students in the general population of the university. Notably, Meyerhoff scholars were also significantly more likely to graduate and retain in science, engineering, and mathematics majors than both their White and Asian peers. Consistently, students in the program were more likely to attend graduate school in a SEM specific field than the comparison group. Specifically, these African American students from the Meyerhoff cohorts were ten times more likely than a historical sample of African American students to attend graduate school in a SEM related field (Maton 2000).

Additionally, the Meyerhoff program has been shown to boost academic and efficacy outcomes for scholars in the program. Since 1996, the program has been open to all students who are committed to diversifying and representing minority populations in science, technology, engineering, and mathematics majors and careers. Later studies have included cohorts in the program which included populations of Meyerhoff scholars who were underrepresented in STEM and not just African American. A longitudinal study analyzed measures taken from sixteen cohorts (1996-2004) and assessed outcomes for all the students in the program. The two most significant factors that predicted program benefit and success were perceived sense of community from summer bridge and enhanced self-efficacy. Sense of community was also a significant predictor for research self-efficacy (Maton, 2016). Notably, 85 percent of original cohorts in the Meyerhoff scholars specifically mention the community as the most positive factor of the program (Maton, 2004).

The Chancellor's Science Scholar program has been informed by this research and as such is structured to foster strong student self-efficacy through community support. The long-term effects of this program cannot yet be seen because the first cohort has not yet graduated. Similar to research conducted on the Meyerhoff Scholars Program, measures of efficacy and community involvement are recorded for each cohort. Successes of students in the Chancellor's Science Scholars have been observed in the University. A recent study matched the first three cohorts of the program (2013-2015) to other STEM majors at the University of North Carolina at Chapel Hill who are not in the program. Chancellor's Science Scholars had significantly higher average science GPA and cumulative GPA scores than science-interested students who were not in the program (Greifer, 2016).

The Present Study

The aims of the current study are exploratory given the novelty of this program; however, several hypotheses are made under the assumption that the program is meeting its goals and is aligned with its theoretical and research supported design. As the first cohort approaches graduation in May 2017, the Chancellor Science Scholars at the University of North Carolina at Chapel Hill will see its first cohort complete the program. Still, there are limitations to what is understood about the success of these students and the unique benefits that this program offers for those students. The program is based on a parent program, the Meyerhoff Scholars program, and is designed to boost STEM achievement and academic self-efficacy by providing academic and social supports. If the program is meeting its goals, students should expect to see gains in science self efficacy over their time in the program. Similarly, as students start to use their education as scientists, conduct research, and develop as professional scientists, program participants should have stronger efficacy. Therefore, it is expected that there is a strong positive correlation between science identity and science self-efficacy.

An important factor in promoting this boost in efficacy is the community within the Chancellor’s Science Scholars Program. The role of community is fundamental for the academic and social development of scholars in the program (Maton, 2000). CSS scholars are required to live with a roommate from the program in the same dorm during the first year and to reside in the dorm with other Chancellor Science Scholar for the following two years. Scholars participate in both social and academic programming with other scholars during their time in their living learning community. Because students in the program have consistent exposure to other scholars in the program in their living community, including the ability to create academic networks within these social groups, it is expected that this factor is influential in this program and actualizing their full potential as scientists. It would follow that one's sense of community throughout the program will be predictive of one's self-efficacy throughout the program science self efficacy across each year in the program.

Sense of community was found to be a critical factor in program benefit for students in the Meyerhoff program (Maton, 2004). In addition to sense of community, science self-efficacy should be predictive of program benefit. If there is a relationship between science self-efficacy and science identity, then science identity will similarly be predictive of program benefit. As explained in Bandura's (1977) model of self-efficacy, as one becomes more confident in his abilities, one puts greater effort in his or her proficient skill. In the case of CSS programming, scholars with strong science self-efficacy may invest in the program's resources and opportunities that will foster their success in their given scientific field. Similarly predicted, overall CSS satisfaction will be significantly explained by a scholars' level of science self efficacy, science identity, and sense of community in the CSS program.

The present evaluations of the Chancellor Science Scholars Program will help administrators improve the program for future scholars while providing empirical support for necessary policy reform to include underrepresented populations in STEM. Using data collected in the Chancellor's Science Scholars Program, the class of 2016 and 2017, student trajectories in the program may be observed. To evaluate resiliency in the STEM this study will analyze the development of students' science self-efficacy through their time in the program. The evaluation will focus on the target areas of the program function to foster this development of science self-efficacy. Additionally, the study will investigate how the social support systems of the program, the summer bridge program, first year housing, and friendships or other social relationships that are made in the program impacts science self-efficacy and academic success throughout students' college career.

The present study aims to address the following research questions: How does science self efficacy change over time for CSS scholars? How does community engagement in the Chancellor's Science Scholars Program predict student's self-efficacy over time? What factors are influential in a CSS scholars' overall program satisfaction? Data from this study will be used to describe how this program has been performing and the factors coordinators would best pay close attention to when trying to improve the overall program.

Method

Participants

In the present study, participants were selected from the Chancellor's Science Scholars program at the University of North Carolina at Chapel Hill. These selected undergraduate students were given surveys to complete at the end of each academic year. The sample for the study included 78 chancellor's science scholars. Twenty students were surveyed at the end of the first year for cohort 1 (class of 2017); 36 students were surveyed at the end of the first year for cohort 2 (class of 2016); 26 students were surveyed at the end of the first year for cohort 3. These initial sample sizes and demographic data do not account for attrition from the study over time by cohort. For cohort 1, at the end of year 1 to 2, two of the original twenty scholars are not surveyed. From year 2 to 3, four more participants are not included. For cohort 2, from year 1 to 2, fourteen scholars are not included in the study. Scholars that did not continue the study are excluded from analyses of changes over time.

The age at which these students were first surveyed ranged from 17 to 19 years of age. Most participants were female (66%). The racial/ethnic representation within the sample consisted of predominately Black students (35.7%) followed by 33% of White students, 16% Hispanic students, and 14% students who identified as another race such as Asian or Native American.

Participants consented to the end of year Chancellor Science Scholars study and interview. The study involved end of year surveys that collected data on students' participation and perceived benefit of both the community and academic aspects of the program. For each cohort, surveys are administered at the end of the summer bridge program and then at the end of each academic year in May. Notably, there were students who either left the program or chose not to participate in surveys in a following year.

Measures

Appendix A provides the specific items for each measure. The following measures summarize all the main study constructs.

Cohort. In each survey, students are grouped by the year in which they entered the program. The numbering starts with the first class of the program (2013), designated with a number 1. The students that are in the first cohort will be the first to graduate from the program and are now seniors. The next incoming class (2014), cohort 2, is now juniors and will graduate in 2018. The pattern follows through the most recent cohort, numbered 4, which is comprised of first year students in the Chancellor Science Scholar program.

Science Self Efficacy. This measure was specifically designed for CSS students to evaluate their capacity to contribute to the field of science. Participants are first asked to rate four items using a five-point Likert-type scale ranging from 1 (*completely disagree*) to 5 (*completely* *agree*). For example, for item 1, participants qualify how much they agree with the statement, "Eventually, I will be a research star in my scientific field" from 1 to 5. The first three items address efficacy as a scientific researcher and the fourth item addresses efficacy as a scientist. The second and fourth items are reverse coded. These reverse coded items and items one and three are averaged to create the measure of science self-efficacy. Alpha reliabilities for this measure were .89, .94, and .94 for cohorts 1, 2, and 3 respectively.

Science Identity. The following measure was designed for CSS students to evaluate how their goal of becoming a scientist relates to their personal identity. Participants are first asked to rank five items using a five-point Likert-type scale ranging from 1 (*completely disagree*) to 5 (*completely agree*). One item reads, "I have come to think of myself as a scientist." Participant would then have to evaluate the degree to reflect on their identity and determine the degree to which they agree with this statement. The ratings from these items are averaged to create the measure of science identity. Alpha reliabilities for this measure were .75 for cohort 1 and .86 and .91 for cohorts 2 and 3 respectively.

Sense of Program Community. This measure was designed to determine how connected students are with other Chancellor Science Scholars'. The measure also measures how much social support students are receiving within the program. Participants are to rank twelve items on a scale identifying the degree to which each statement represents their feelings about the Chancellor Science Scholars program community from 1 (not at all) to 4 (completely). One item reads, "I can recognize most of the members of the program." The second part of the construct includes questions with responses on a Likert-type scale ranging from 1 (little or none) to 5 (the most). These items are then averaged to create the measure of sense of community. The alpha reliabilities for this measure by cohort was .71, .89, and .86.

Perceived Program Benefit. This measure is used to evaluate what services and resources students in the CSS program took advantage of and benefitted from the most. Participants rated items to assess how useful these resources were in the program on a scale from 1 (*not useful*) to 4 (*very useful*). One example of a resource students evaluated was academic advising conducted by the CSS programming staff.

Overall Program Satisfaction. This measure is used to evaluate students' perceived benefit from the program. Students rate six statements about the quality of the overall program from 1 (*strongly disagree*) to 7 (*strongly agree*). One item reads, "So far I have gotten the important things I want in the CSS program." Students would then rate this item based on the degree to which they agree. Their scores from the six statements are averaged to compute the measure for program satisfaction. The alpha reliabilities were .70, .83, and .82 for cohorts 1, 2, and 3 respectively.

Analysis Plan

All study analyses were conducted using SPSS 24. Correlations were conducted for all measures of interest. Initially, descriptive statistics including relevant frequencies and histograms were first analyzed. To determine whether the program influences self-efficacy trajectories, we used longitudinal data from the first and second cohort to assess whether self-efficacy has changed significantly for each cohort year by year. To assess changes in efficacy over time for cohorts, t-tests and repeated measure oneway ANOVA was used. In particular, the relationship between science self efficacy and science identity was assessed to test the first hypothesis. Effect sizes were also calculated for these tests. For tests involving multiple data points per cohort, students with missing data in any year were omitted from analyses. To further explain significant correlations between measures of interest, hierarchical regressions were conducted. The first model tested whether sense of community is a predictor of science self efficacy in cohorts 1 and 2. Then across all cohorts, hierarchical regression testing whether science self-efficacy, science identity, or sense of community are significant predictors of overall CSS satisfaction and program benefit.

Results

Table 1 shows descriptive statistics of CSS constructs used in the study including means, standard deviations, and alpha reliabilities. Table 2 includes all bivariate correlations between CSS variables of interest. Correlations were performed with 2016 data that includes cohort 1 end of year 3, cohort end of year 2 and cohort 3 year 1.

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Contrary to the original hypothesis, no significant correlation was found between science self-efficacy and science identity, $r(58) = .19$, $p > .05$. Science self efficacy and overall CSS satisfaction were significantly correlated, $r(58) = .34$, $p < .05$. Significant positive correlations were found between science identity and overall CSS satisfaction, $r(58) = .44$, $p < .01$ and sense of community and program benefit $r(58) = .41$, $p < .01$. A strong positive correlation was found between CSS satisfaction and program benefit $r(58) = .61$, $p < .001$. All correlations can be found in Table 2.

Descriptive results indicate that students tended to believe in their capabilities to contribute to science overall at the end of their first year ($M = 3.77$, $SD = .62$), but science efficacy scores slightly decreased at the end of year two ($M = 3.64$, $SD = .69$) and slightly rose at the end of the third year ($M = 3.90$, $SD = .69$). Results from the repeated one-way ANOVA indicate that there were no significant changes in science-self efficacy over time for cohort 1, $F(2,50) = .580$, $p > .05$.

All cohorts showed a significant decrease in sense of community over time. Cohort 1 showed the most significant decrease from end of year 1 (*M*= 3.10, *SD*= 2.63) to the end of year 2 (*M*= 2.63, *SD*= .52), *t*(16)= .027, $p < .05$; (*d*=1.06). The effect size for this difference in particular exceeds Cohen's (1988) standard for a large effect (*d*= .80). There is another significant decrease in sense of community from year 2 to the end of year 3 (*M*= 2.23, *SD*= .56), *t*(13)= 2.37, $p < .05$; (*d* = .74). The value of Cohen's d indicates a large effect size. For cohort 2, a significant decrease in sense of community is seen from year 1 to year 2, *t*(30)= 2.33, $p < .01$; (*d* = .01), but a small effect size.

Before analyzing which factors were predictive of overall CSS satisfaction, the assumption for normality was verified, *W*(54)= .96, $p > .05$. The overall model for predicting CSS satisfaction by sense of community, science identity, science self-efficacy, and program benefit was extremely significant *F*(4,53)= 13.02, $p < .01$. Sense of community was found to be the strongest predictor of overall program satisfaction, *t*(57)= 3.71, $p < .01$, followed by science identity, *t*(57)= 2.57, $p < .05$. Science self efficacy was not predictive of overall CSS satisfaction, *t*(57)= -1.47, $p > .05$. All values can be seen in Table 3.

When analyzing which factors were instead predictive of perceived program benefit, similar results were found. Perceived program benefit also met assumptions of normality, *W*(57)= .97, $p > .05$. The overall model was significant *F*(3, 54) = 5.61, $p < .01$. Sense of program community was also a significant predictor of program benefit, *t*(57)= 3.50 $p < .01$, as was science identity, *t*(57)= -2.03, $p < .05$. All these values can be seen in table 4 below. Science self-efficacy was not predictive of program benefit, *t*(57)= 1.263, $p > .05$. Sense of community also was not predictive of science-self efficacy, *F*(1, 56)= 3.20, $p > .05$. It is important to note that overall science self-efficacy was not found to meet normality assumptions, $W(57) = .23$, $p < .01$.

Discussion

The results show a different pattern than suggested by the original hypothesis that efficacy improves throughout the program. Instead, efficacy remained relatively stable over time. Sense of community was also not found to be a predictor of self-efficacy, but instead a predictor of overall CSS satisfaction. However, this sense of community measure was seen to decrease over time for both cohorts 1 and 2. This decrease in sense of community over time could account for why it was not found to be a significant predictor of efficacy, a more stable measure. The relationship between science self-efficacy and science identity were not found to be significant. To evaluate science identity, it is important to understand what students believe about science. While CSS is committed to bringing students into STEM doctoral programs and enhancing learning experiences with research opportunities, not every student benefits from these experiences. Certain scholars do not want to become researchers and are seeking other paths in science careers.

> *Case A: "Maybe I wish a little bit that it was more towards science in general and not just pushing us towards grad school. That's a great option, to do MD/Ph.D. and Ph.D. I wish they would give us more help with also doing a professional career."*

Sense of community and science identity are both significant predictors of overall CSS satisfaction and program benefit. As expected, there is a strong correlation between overall CSS satisfaction and program benefit. This follows the assumption of the program that those who use more of the program's resources and take advantage of opportunities will be more satisfied with their experience in CSS. The decrease in sense of community should be addressed because a strong sense of community is a highly significant predictor of satisfaction and benefit in the CSS program. The lowering sense of community in cohorts needs to be something program directors address given the promise community has for instilling academic motivation, providing social support, and contributing to overall satisfaction.

One of the greatest study limitations is the small sample size of cohort. With larger samples compiled, more sophisticated analyses examining the effect of gender, race, and socio-economic status on program constructs of interest could be run. Unlike the Meyerhoff Scholar's Program, there were no long-term results that can be seen. In fact, at the time this study was conducted, no scholars had entered their senior year. There may be more effects seen throughout the full college experience that may not be seen in just one or two years. Also, one cannot make predictions of future outcomes for these students simply because May 2017 will mark the first graduation of a CSS cohort. Particularly for cohort 2 and 3, the full effects of the program are seen even less as they have spent less time in the program than cohort 1.

Another study limitation may arise from developing construct scales without any student input. The measures were selected from standard measures in the field. However, there appears to be some ambiguity in how the scales were combined. One student comments, *"The wording of the survey questions occasionally make them extremely ambiguous and open for many different interpretations. I'm not sure how useful such questions and answers could be for concrete research purposes."* Similarly, these evaluations communicate a specific definition of science and what it means to be a scientist which as seen in interview case A, not everyone agrees with.

Still, it is entirely possible to become a scientist without doing research. Students who do not participate in research may feel they do not meet the program's standard of science and rate lower on these scales, when in fact their other applications of science may be strong. The definitions of science should be open to students' interpretation, and inclusive of all career paths in the field of STEM.

Another limitation is controlling for the surrounding college environment. While CSS works to foster an environment that lends itself to promoting science scholarship and diversity, there is little evidence that this community differs from Chapel Hill's broader science community. There should be more comparison studies using UNC science majors outside the program as a control. There may be opportunities in the broader community outside of the structured environment of CSS that may be beneficial to students as well. CSS primarily focuses on scholarship in STEM, but students have other values as seen in case B below.

Case B: "I want them to stress not – it sounds kind of bad, but stress not school. Stress students going to school, but not only being students."

To understand better the impact of the Chancellor's Science Scholars program holistically, its individual components should be analyzed. In particular, summer bridge should be compared and used as a baseline for comparison as students continue in the program. The constructs used for summer bridge and CSS use different items and scales. These measures could be standardized, but some of these differences between constructs would affect internal validity. In future studies, these constructs should be matched and mapped. With regard to boosting efficacy, summer bridge programs function to improve a students' confidence in his or her academic abilities. These gains in efficacy are seen to have lasting effects throughout a students' college career in persisting in his or her field of study (Allen, 2011). Instead of expecting CSS promoting gains of efficacy, it may be more effective to see how students' efficacy changes over summer bridge. In future studies of CSS cohorts, students should be assessed on changes not only in the program, but also throughout summer bridge.

Relationships between CSS students are another subject in need of more study. While declining sense of community overall was observed, it was not clear how smaller communities or relationships within CSS function and how they may have similar effects and impact in students' careers. Further study should be conducted on how these relationships, particularly first year roommates, effect students' experience in the program and serve as an added support system. One's roommate is an instant connection who also understands a students' experience by being in the same program, pursuing STEM. These similar experiences promote roommate bonding and support as seen in case C.

> *Case C: "My roommate is my go-to person if I'm like emotionally stressed because he and other cohort members like know because it's so hard – so frustrating when people do not realize how hard it is to actually go through what we're doing with all the science courses."*

Presently, CSS evaluations and interviews occur at the end of each academic year. While creating consistency between summer bridge and CSS evaluations, program coordinators need more student input into developing their programs for the year. Students do not have an opportunity to voice their opinions about what they'd like to see in the program until the end of their first year. This first year in the program is critical. It is the most immersive in the program because students are paired with a roommate who is also a first year student in the program. The first year has been found to be a memorable year due to the emotional nature of the transition (Pillemer, 1986). The social relationships that students create are critical to students having resiliency through the difficult parts of this transition.

Found to be a significant predictor of program satisfaction and benefit, sense of community is critical to a student's investment and success in the program. Still, some students are not particularly involved in the CSS community and do not find these social programs to be beneficial. Program staff need to reach out to those who are not involved in the community and not attending events. There should be intervention studies conducted about students can be best involved in the community. There should be more evaluations or short surveys after events so that scholars may provide feedback on what they enjoy about social programming and what could be improved for future events.

Lastly, there needs to be more research conducted on how race, gender, and socio-economic status affect student outcomes in the program. Representation can be more effective in reaching students on a personal level as shown in case D.

Case D: "Especially as a woman, that was really powerful because there was other woman who also was a researcher so she could tell us like exactly how it is. And so that was helpful."

The Chancellor's Science Scholar Program was created with a similar structure to the Meyerhoff Scholars program. Programmers developed evaluation strategies and community events similar to those in the Meyerhoff program. Meyerhoff found more rapid success and in particular boosts in efficacy than CSS has. A critical difference between these two programs is their applicant demographic criteria. Where Meyerhoff began with a cohort of only African American students, the CSS program began accepting students of all races and backgrounds. Still there is evidence of improvement in the community as shown in Case E.

Case E: ""I think the program is going to be very successful in the future especially since having seen how CSS 2 are much strongly bonded compared to CSS 1. I think it's an indication of how successful the Summer Bridge program was"

The culture of the CSS program is heterogeneous and as such, it can be more difficult to plan effective group level plans that are inclusive of all students' diverse needs. The CSS program needs to be culturally aware and receptive to the needs of all its students. Further evaluating these services and outcomes based on race, gender, and socio-economic status is critical to maintaining equity, cultural sensitivity, and upholding CSS' mission of empowering diversity in science, technology, engineering, and mathematics.

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Table 1. Descriptive Statistics for CSS Constructs of Interest

				Cohort 1				Cohort 2				Cohort 3			
Scale	***Items***	***Min***	***Max***	***M***	***SD***	***n***	**α**	***M***	***SD***	***n***	**α**	***M***	***SD***	***n***	**α**
Program Satisfaction															
End of Year 1	6	1	7	4.61	.88	20	.70	5.25	1.11	31	.85	4.76	1.35	26	.90
End of Year 2	6	1	7	4.37	1.07	18	.83	4.39	1.20	18	.83	-	-	-	-
End of Year 3	6	1	7	4.06	1.07	14	.82	-	-	-	-	-	-	-	-
Program Benefit															
End of Year 1	6	1	5	3.83	.59	20	.74	3.97	.75	32	.78	3.61	0.80	26	.88
End of Year 2	6	1	5	3.39	.64	18	.78	3.64	.64	18	.79	-	-	-	-
End of Year 3	6	1	5	3.33	.60	14	.78	-	-	-	-	-	-	-	-
Scientific Identity															
End of Year 1	5	1	5	3.63	.68	20	.74	3.79	0.71	31	.89	3.76	0.68	26	.86
End of Year 2	5	1	5	3.49	.68	18	.86	3.56	0.92	18	.92	-	-	-	-
End of Year 3	5	1	5	3.24	.92	14	.91	-	-	-	-	-	-	-	-
Science Self Efficacy															
End of Year 1	15	1	5	3.77	.62	20	.89	3.80	0.68	31	.93	3.61	0.71	26	.94
End of Year 2	15	1	5	3.64	.69	18	.94	3.76	0.61	18	.91	-	-	-	-
End of Year 3	15	1	5	3.90	.68	14	.94	-	-	-	-	-	-	-	-
Sense of Program Community															
End of Year 1	12	1	4	3.10	.33	20	.71	3.32	0.55	31	.93	2.86	0.70	26	.94
End of Year 2	12	1	4	2.63	.52	18	.89	3.13	0.51	18	.86	-	-	-	-
End of Year 3	12	1	4	2.23	.56	14	.86	-	-	-	-	-	-	-	-

Table 2. Correlations Between CSS

		scienceselfefficacy	CSS-satisfaction	Senseofcomm-unity	Science Identity	programbenefit_3
scienceselfefficacy	Pearson Correlation	1	.34**	.23	.19	.21
	Sig. (2-tailed)		.009	.08	.16	.11
	N	58	58	58	58	58
CSSsatisfaction	Pearson Correlation	.34**	1	.61**	.44**	.327*
	Sig. (2-tailed)	.009		< .001	.001	.012
	N	58	58	58	58	58
senseofcommunity	Pearson Correlation	.23	.61**	1	.28*	.41**
	Sig. (2-tailed)	.079	.000		.032	.002
	N	58	58	58	58	58
Science Identity	Pearson Correlation	.19	.44**	.28*	1	-.10
	Sig. (2-tailed)	.16	.001	.032		.45
	N	58	58	58	58	58
programbenefit	Pearson Correlation	.21	.327*	.41**	-.10	1
	Sig. (2-tailed)	.11	.012	.002	.454	< .001
	N	58	58	58	58	58

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 3. CSS Satisfaction Regression Output

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound
1	(Constant)	-1.288	.946		-1.361	.179	-3.185	.610
	scienceselfefficacy	.282	.192	.151	1.472	.147	-.102	.666
	programbenefit	.282	.205	.153	1.373	.175	-.130	.694
	senseofcommunity	.775	.209	.426	3.711	.000	.356	1.194
	Science Identity	.462	.160	.306	2.879	.006	.140	.784

a. Dependent Variable: csssatisfaction

Table 4: Program Benefit Regression Output

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound
1	(Constant)	2.136	.555		3.848	.000	1.023	3.249
	senseofcommunity	.437	.125	.442	3.500	.001	.187	.688
	Science Identity	-.208	.102	-.254	-2.033	.047	-.414	-.003
	scienceselfefficacy	.158	.125	.156	1.263	.212	-.093	.409

a. Dependent Variable: programbenefit

Appendix

Construct Items: Science Self-Efficacy

Think about your ability to do the tasks required to complete scientific research. When answering the following questions, answer in reference to your own personal research skills and ability to perform as a competent scientist.

	Not at all Confident (1)	Somewhat Confident (2)	Moderately Confident (3)	Very Confident (4)	Absolutely Confident (5)
a. Use technical science skills (use of tools, instruments, and/or techniques) (1)	❍	❍	❍	❍	❍
b. Generate a research question to answer (2)	❍	❍	❍	❍	❍
c. Figure out what data I should collect (3)	❍	❍	❍	❍	❍
d. Collaborate with other scientists (4)	❍	❍	❍	❍	❍
e. Figure out the methods I should use (5)	❍	❍	❍	❍	❍
f. Show integrity as a scientist (6)	❍	❍	❍	❍	❍
g. Be resilient if a project doesn't go my way (7)	❍	❍	❍	❍	❍
h. Be persistent in seeking an answer (8)	❍	❍	❍	❍	❍
i. Be a good lab citizen (9)	❍	❍	❍	❍	❍
j. Be open to criticism (10)	❍	❍	❍	❍	❍
k. Be meticulous in record keeping (11)	❍	❍	❍	❍	❍
l. Create explanations for the results of the study (12)	❍	❍	❍	❍	❍
m. Use scientific literature and/or reports to guide research (13)	❍	❍	❍	❍	❍
n. Develop theories by integrating and coordinating results from multiple studies (14)	❍	❍	❍	❍	❍
o. Report research results in an oral presentation (15)	❍	❍	❍	❍	❍

Construct and Items: Science Identity

"The following questions ask how you think about yourself and your personal identity. We want to understand how much you think that being a scientist is part of who you are."

	Strongly Disagree (1)	Disagree (2)	Neither Disagree Nor Agree (3)	Agree (4)	Strongly Agree (5)
a. I have a strong sense of belonging to the community of scientists. (1)	❍	❍	❍	❍	❍
b. I derive great personal satisfaction from working on a team that is doing important research. (2)	❍	❍	❍	❍	❍
c. I have come to think of myself as a 'scientist.' (3)	❍	❍	❍	❍	❍
d. I feel like I belong in the field of science. (4)	❍	❍	❍	❍	❍
e. The daily work of a scientist is appealing to me. (5)	❍	❍	❍	❍	❍

Construct and Items: Perceived Program Benefit

"Which of the following have you found beneficial during your time in CSS?"

	Not at all useful (1)	Somewhat useful (2)	Useful (3)	Very useful (4)	Not applicable (5)
a. Chancellor's Science Scholars financial scholarship (1)	❍	❍	❍	❍	❍
b. Study groups (2)	❍	❍	❍	❍	❍
c. Receiving tutorial services (3)	❍	❍	❍	❍	❍
d. Giving tutorial services (4)	❍	❍	❍	❍	❍
e. Academic advising by faculty (5)	❍	❍	❍	❍	❍
f. Academic advising by program staff (e.g. Beth Shuster or Deborah Graczyk) (6)	❍	❍	❍	❍	❍
g. Academic advising by cohort members (7)	❍	❍	❍	❍	❍
h. Personal counseling by program coordinator(s) (8)	❍	❍	❍	❍	❍
i. Personal counseling by other program staff (10)	❍	❍	❍	❍	❍
j. Mentoring or support by cohort members (9)	❍	❍	❍	❍	❍

	Not at all (1)	Somewhat (2)	Mostly (3)	Completely (4)
a. I get important needs of mine met because I am part of the Chancellor's Science Scholars program. (1)	❍	❍	❍	❍
b. Program members and I value the same things. (2)	❍	❍	❍	❍
c. When I have a problem, I can talk about it with members of the program. (3)	❍	❍	❍	❍
d. I can trust people in the program. (4)	❍	❍	❍	❍
e. I can recognize most of the members of the program. (5)	❍	❍	❍	❍
f. Most program members know me. (6)	❍	❍	❍	❍
g. Being a member of the Chancellor's Science Scholars program is a part of my identity. (7)	❍	❍	❍	❍
h. I have influence over what the program is like. (8)	❍	❍	❍	❍
i. If there is a problem in the program, members can get it solved. (9)	❍	❍	❍	❍
j. I am with the other Chancellor's Science Scholars a lot and enjoy being with them. (10)	❍	❍	❍	❍
k. I expect to be a part of the program for a long time. (11)	❍	❍	❍	❍
l. Members of the program care about each other. (12)	❍	❍	❍	❍

"How well does each statement represent how you feel about the Chancellor's Science Scholars Program?"